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Global, Regional, and National Cancer Incidence, Mortality, Years of Life Lost, Years Lived With Disability, and Disability-Adjusted Life-Years for 29 Cancer Groups, 1990 to 2017

A Systematic Analysis for the Global Burden of Disease Study

Global Burden of Disease Cancer Collaboration

IMPORTANCE Cancer and other noncommunicable diseases (NCDs) are now widely recognized as a threat to global development. The latest United Nations high-level meeting on NCDs reaffirmed this observation and also highlighted the slow progress in meeting the 2011 Political Declaration on the Prevention and Control of Noncommunicable Diseases and the third Sustainable Development Goal. Lack of situational analyses, priority setting, and budgeting have been identified as major obstacles in achieving these goals. All of these have in common that they require information on the local cancer epidemiology. The Global Burden of Disease (GBD) study is uniquely poised to provide these crucial data.

OBJECTIVE To describe cancer burden for 29 cancer groups in 195 countries from 1990 through 2017 to provide data needed for cancer control planning.

EVIDENCE REVIEW We used the GBD study estimation methods to describe cancer incidence, mortality, years lived with disability, years of life lost, and disability-adjusted life-years (DALYs). Results are presented at the national level as well as by Socio-demographic Index (SDI), a composite indicator of income, educational attainment, and total fertility rate. We also analyzed the influence of the epidemiological vs the demographic transition on cancer incidence.

FINDINGS In 2017, there were 24.5 million incident cancer cases worldwide (16.8 million without nonmelanoma skin cancer [NMSC]) and 9.6 million cancer deaths. The majority of cancer DALYs came from years of life lost (97%), and only 3% came from years lived with disability. The odds of developing cancer were the lowest in the low SDI quintile (1 in 7) and the highest in the high SDI quintile (1 in 2) for both sexes. In 2017, the most common incident cancers in men were NMSC (4.3 million incident cases); tracheal, bronchus, and lung (TBL) cancer (1.5 million incident cases); and prostate cancer (1.3 million incident cases). The most common causes of cancer deaths and DALYs for men were TBL cancer (1.3 million deaths and 28.4 million DALYs), liver cancer (572 000 deaths and 15.2 million DALYs), and stomach cancer (542 000 deaths and 12.2 million DALYs). For women in 2017, the most common incident cancers were NMSC (3.3 million incident cases), breast cancer (1.9 million incident cases), and colorectal cancer (819 000 incident cases). The leading causes of cancer deaths and DALYs for women were breast cancer (601 000 deaths and 17.4 million DALYs), TBL cancer (596 000 deaths and 12.6 million DALYs), and colorectal cancer (414 000 deaths and 8.3 million DALYs).

CONCLUSIONS AND RELEVANCE The national epidemiological profiles of cancer burden in the GBD study show large heterogeneities, which are a reflection of different exposures to risk factors, economic settings, lifestyles, and access to care and screening. The GBD study can be used by policy makers and other stakeholders to develop and improve national and local cancer control in order to achieve the global targets and improve equity in cancer care.

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Supplemental content

CME Quiz at jamacmelookup.com and CME Questions page 1816

Group Information: The members of the Global Burden of Disease Cancer Collaboration appear at the end of the article.

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Cancer is now widely recognized as a global problem that unfortunately lacks a global solution. The latest United Nations high-level meeting on noncommunicable diseases (NCDs) exemplified this conundrum.[1] Despite global commitment to reducing the risk of and disability from NCDs, including cancer, implementation of known solutions is inadequate to reach the 2011 Political Declaration on the Prevention and Control of Noncommunicable Diseases[2,3] (25% reduction in premature mortality from NCDs by 2025) and the third Sustainable Development Goal (by 2030 reduce by one-third premature mortality from NCDs through prevention and treatment, and promote mental health and well-being).[4] To reduce cancer burden, identifying the scope of the problem and mapping out implementation of solutions is best done in National Cancer Control Plans (NCCPs). However, a recent review showed that only 29% of low-income countries had a NCCP, and even if NCCPs existed, cost, financing, monitoring, and expansion of information systems was often inadequate. Many highly effective prevention and treatment strategies exist for cancer. However, they are often very specific (eg, vaccination for human papillomavirus and hepatitis B virus for prevention of cervical and liver cancer, or tyrosine kinase inhibitors for cancers with targetable mutations). Effective NCCPs therefore require detailed knowledge about the local burden of cancer and associated risk factors. We herein present results from the Global Burden of Disease (GBD) 2017 study describing cancer incidence, mortality, years of life lost (YLLs), years lived with disability (YLDs), and disability-adjusted life-years (DALYs) for 195 countries from 1990 through 2017, which can inform cancer control through policy, resource allocation, and health system planning.

Key Points

Question What is the cancer burden over time at the global and national levels, measured in incidence, mortality, years lived with disability, years of life lost, and disability-adjusted life-years (DALYs), and how does it compare with other diseases?

Findings Results of this systematic analysis show that in 2017 there were 24.5 million incident cases (16.8 million without nonmelanoma skin cancer), 9.6 million deaths, and 233.5 million DALYs due to cancer; between 2007 and 2017, incident cases increased by 33%, with the lowest increase in the most developed countries, and between 1990 and 2017 neoplasms increased among the top causes of DALYs from the sixth to the second place. Fifty-one percent of cancer cases occurred in countries of high Socio-demographic Index, but only 30% of cancer deaths and 24% of cancer DALYs.

Meaning To ensure sustainable global development, increased efforts are needed in cancer prevention and in ensuring universal access to cancer care.

Methods

Methods have remained similar to the GBD 2016 study.[5] Detailed descriptions of the methods can be found in the GBD 2017 publications[6-9] as well as in the eAppendix, eFigures, and eTables in the Supplement. For each GBD study, the entire time series is re-estimated. This study therefore supersedes prior GBD iterations. The GBD study is compliant with the Guidelines for Accurate and Transparent Health Estimates Reporting statement (eTable 1 in the Supplement). Compared with the prior GBD study (GBD 2016), the neoplasms category for GBD 2017 also includes benign and in situ neoplasms (*International Statistical Classification of Diseases and Related Health Problems, Tenth Revision* [*ICD-10*] codes D00-D49). Because disability associated with benign neoplasms is most often very small, we only estimated disability for the new cause: myelodysplastic, myeloproliferative, and other hematopoietic neoplasms. The terms *malignant neoplasms* or *cancer* in this article only include *ICD-10* codes C00 through C96. Other changes since GBD 2016 are the addition of new data sources (eTable 3 in the Supplement) for GBD 2017 and improvements in the way we estimated cancer survival by using the mortality-to-incidence ratio (MIR). In this study, estimates are presented for 29 cancer categories and 195 countries and territories. Estimates for benign neoplasms as well as selected subnational estimates are available online (https://vizhub.healthdata.org/gbd-compare/ and http://ghdx.healthdata.org/gbd-results-tool). All rates are reported per 100 000 person-years. The GBD world population standard was used for the calculation of age-standardized rates.[9] We report 95% uncertainty intervals for all estimates.

Estimation Framework

The GBD cancer estimation process starts with mortality. Mortality estimates are made based on vital registration system (83% of data), cancer registry (16% of data) (eTable 3 in the Supplement), and verbal autopsy data (1% of data) using an ensemble model approach.[9,10] Predictive covariates used in the model can be found in the eAppendix (eTable 8 in the Supplement). Single-cause mortality estimates are scaled into the separately estimated all-cause estimate.[9] To estimate cancer incidence, mortality estimates are divided by a separately estimated MIR for each cancer type, sex, 5-year age group, location, and year; additional information regarding incidence and MIR estimation can be found in the eAppendix and eFigure 2 in the Supplement. Data sources used for estimating MIRs are described in eTable 2 in the Supplement. MIRs allow for a uniform method to estimate incidence. Other cancer estimation frameworks[11,12] have set a precedent for using MIRs for decades and have detailed its benefits, including greater representativeness, especially in settings that lack quality or complete population-based cancer registry systems. By determining incidence using mortality, we are able to account for uncaptured incident cases and, if mortality and incidence are determined correctly, estimating incidence based on MIRs should result in the similar results if using incidence directly. The correlation between survival data and the MIR is used to estimate 10-year cancer prevalence. Total prevalence is partitioned into 4 sequelae: (1) diagnosis/treatment, (2) remission, (3) metastatic/disseminated, and (4) terminal phase. Each sequela prevalence is multiplied by a disability weight to estimate YLDs. Lifetime prevalence of procedure-related disability is estimated for larynx, breast, colorectal, bladder, and

prostate cancers. A standard life expectancy is used to estimate years of life lost (YLLs).[9] DALYs are the sum of YLDs and YLLs. To determine the contribution of population aging, population growth, and change in age-specific rates on the change in incident cases between 2007 and 2017, we use hypothetical demographic scenarios holding 2 of these 3 components constant. Results are stratified by quintiles of Sociodemographic Index (SDI), which is a composite indicator including fertility, education, and income.[7]

Results

Global Incidence, Mortality, and DALYs

In 2017, there were 24.5 million (95% UI, 22.0-27.4 million) incident cancer cases worldwide and 9.6 million (95% UI, 9.4-9.7 million) cancer deaths (**Table**). Cancer caused 233.5 million (95% UI, 228.8-238.0 million) DALYs in 2017, of which 97% came from YLLs and 3% came from YLDs (eTable 15 and eFigure 4 in the Supplement). Globally, the odds of developing cancer during a lifetime (ages 0-79 years) were 1 in 3 for men and 1 in 4 for women (eTable 16 in the Supplement). These odds differ substantially among SDI quintiles, ranging from 1 in 7 at the lowest SDI quintile to 1 in 2 at the highest SDI quintile for both sexes. In 2017, skin; tracheal, bronchus, and lung (TBL); and prostate cancers were the most common incident cancers in men, accounting for 54% of all cancer cases. The most common causes of cancer deaths and DALYs for men were TBL, liver, and stomach cancers (Table). For women in 2017, the most common incident cancers were nonmelanoma skin cancer (NMSC), breast cancer, and colorectal cancer, accounting for 54% of all incident cases. The leading causes of cancer deaths and DALYs for women were breast, TBL, and colorectal cancers.

Between 2007 and 2017, the average annual age-standardized incidence rates (ASIRs) for all cancers combined increased in 123 of 195 countries (**Figure 1** and eFigure 5 in the Supplement). In contrast, the average annual age-standardized death rates for all cancers combined decreased within that timeframe in 145 of 195 countries (**Figure 2** and eFigure 6 in the Supplement). Incident cases for both sexes combined increased in all SDI quintiles between 2007 and 2017 for nearly all cancers (eTable 14 in the Supplement). The largest increase in cancer incident cases between 2007 and 2017 occurred in middle SDI countries, with a 52% increase, of which changing age structure contributed 24%, population growth 10%, and changing age-specific incidence rates 18%. The drivers behind increasing cancer incidence differ substantially by SDI. Whereas in the lowest SDI quintile, population growth is the major contributor to the increase in total cancer incidence, in low-middle SDI countries aging and changes in incidence rates contribute equally (each 12%), and in high-middle and high SDI countries, increased incidence is mainly driven by population aging (eTable 14 in the Supplement).

Global Top 10 Cancers in 2017

The global top 10 cancers were ranked by the highest number of incident cases, excluding "other malignant neoplasms."

1. Nonmelanoma Skin Cancer

In 2017, there were 7.7 million (95% UI, 5.3-10.6 million) incident cases of NMSC, of which 5.9 million (95% UI, 3.7-8.7 million) were due to basal cell carcinoma and 1.8 million (95% UI, 1.1-2.6 million) due to squamous cell carcinoma. There were 65 000 (95% UI, 63 000-66 000) deaths due to NMSC (Table) and 1.3 million (95% UI, 1.3-1.4 million) DALYs, of which 97% came from YLLs (**Figure 3**) and 3% from YLDs (eTable 15 and eFigure 4 in the Supplement). Over a lifetime, the odds of developing NMSC were 1 in 7 for men and 1 in 10 for women globally. For men, the odds ranged from 1 in 71 in low SDI countries to 1 in 2 in high SDI countries, and for women from 1 in 104 in low SDI countries to 1 in 4 in high SDI countries (eTable 16 in the Supplement). An aging and growing population has led to a 33% (95% UI, 29%-36%) increase in NMSC cancer cases, from 5.8 million (95% UI, 4.1-7.8 million) in 2007 to 7.7 million (95% UI, 5.3-10.6 million) in 2017. The majority of this increase (20%) can be attributed to a change in the population age structure, and 13% can be attributed to population growth (eTable 14 and eFigure 11 in the Supplement).

2. Tracheal, Bronchus, and Lung Cancer

In 2017, there were 2.2 million (95% UI, 2.1-2.2 million) incident cases of TBL cancer and 1.9 million (95% UI, 1.8-1.9 million) deaths. Tracheal, bronchus, and lung cancer caused 40.9 million (95% UI, 40.0-41.9 million) DALYs in 2017, of which 99% came from YLLs and 1% from YLDs (eTable 15 and eFigure 4 in the Supplement). Men were more likely to develop TBL cancer over a lifetime than women (1 in 17 men vs 1 in 43 women) (eTable 16 in the Supplement). The odds were the highest in high-middle SDI countries for men (1 in 13) and in high SDI countries for women (1 in 28). In low SDI countries, the odds were the lowest (1 in 45 for men and 1 in 142 for women). Tracheal, bronchus, and lung cancer was the leading cause of cancer in high-middle SDI countries (eFigure 5 in the Supplement). It was the most common cause of cancer deaths by absolute cases globally, as well as in all SDI quintiles (eFigure 6 in the Supplement). For men, TBL cancer was the most common incident cancer in 48 countries and the most common cause for cancer deaths in 110 countries (eFigures 7 and 9 in the Supplement). For women, TBL cancer was the most common incident cancer in Greenland and the most common cause of cancer deaths in 22 countries (eFigures 8 and 10 in the Supplement). Between 2007 and 2017, TBL cancer cases increased by 37% (95% UI, 33%-40%). Changing age structure contributed 19%, population growth 13%, and changes in age-specific incidence rates 5% (eTable 14 and eFigure 11 in the Supplement). The ASIRs between 1990 and 2017 show diverging results between men and women globally and in high SDI countries, with ASIRs decreasing in men but increasing in women (eFigure 12 in the Supplement). In high-middle SDI countries, ASIRs remained stable for men but increased for women, whereas rates increased for both sexes in middle SDI countries (eFigures 13 and 14 in the Supplement).

3. Breast Cancer

Breast cancer was the third most common incident cancer overall with an estimated 2.0 million (95% UI, 1.9-2.0 million) in-

Table. 2017 Global Incidence and Deaths for All Cancers and 29 Cancer Groups[a]

Cancer Type[b]	Incident Cases, Thousands[c]			ASIR (per 100 000)		Deaths, Thousands			ASDR (per 100 000)	
	Total	Male	Female	Male	Female	Total	Male	Female	Male	Female
All malignant neoplasms	24 491 (22 041-27 441)	13 294 (11 932-15 035)	11 197 (10 129-12 450)	365 (327-415)	265 (240-295)	9556 (9396-9692)	5442 (5325-5554)	4114 (4016-4201)	151.5 (148.2-154.6)	96.9 (94.5-98.9)
Lip and oral cavity	390 (374-404)	239 (226-249)	151 (144-159)	6.2 (5.9-6.5)	3.6 (3.4-3.8)	194 (185-202)	125 (117-131)	69 (65-72)	3.3 (3.1-3.5)	1.6 (1.5-1.7)
Nasopharynx	110 (104-116)	81 (76-87)	29 (27-30)	2.0 (1.9-2.2)	0.7 (0.7-0.7)	70 (67-72)	51 (48-54)	19 (18-19)	1.3 (1.3-1.4)	0.4 (0.4-0.5)
Other pharynx	179 (160-189)	131 (114-141)	48 (45-51)	3.3 (2.9-3.6)	1.1 (1.1-1.2)	117 (102-124)	84 (70-91)	33 (31-36)	2.2 (1.8-2.4)	0.8 (0.7-0.8)
Esophageal	473 (459-485)	331 (319-342)	142 (135-148)	8.9 (8.6-9.2)	3.3 (3.2-3.5)	436 (425-448)	311 (300-321)	125 (120-130)	8.4 (8.1-8.7)	2.9 (2.8-3.1)
Stomach	1221 (1189-1255)	799 (771-830)	421 (408-434)	21.7 (21.0-22.6)	9.9 (9.6-10.2)	865 (848-885)	546 (531-564)	319 (310-328)	15.2 (14.8-15.7)	7.5 (7.3-7.7)
Colon and rectum	1833 (1792-1873)	1015 (977-1047)	819 (795-839)	28.0 (27.0-28.9)	19.2 (18.6-19.6)	896 (876-916)	482 (465-498)	414 (401-423)	13.8 (13.3-14.2)	9.6 (9.4-9.9)
Liver	953 (917-997)	690 (654-734)	264 (254-275)	17.9 (17.0-19.1)	6.2 (6.0-6.5)	819 (790-856)	572 (543-610)	247 (239-257)	15.1 (14.4-16.1)	5.8 (5.6-6.0)
Gallbladder and biliary tract	211 (186-225)	90 (77-100)	120 (104-131)	2.6 (2.2-2.9)	2.8 (2.4-3.1)	174 (154-185)	72 (60-79)	102 (89-110)	2.1 (1.8-2.3)	2.4 (2.1-2.6)
Pancreatic	448 (439-456)	232 (225-239)	215 (210-221)	6.4 (6.2-6.6)	5.0 (4.9-5.2)	441 (433-449)	226 (219-233)	215 (211-220)	6.3 (6.1-6.5)	5.0 (4.9-5.1)
Larynx	211 (206-216)	178 (174-183)	33 (32-34)	4.6 (4.5-4.7)	0.8 (0.7-0.8)	126 (123-130)	106 (103-109)	21 (20-22)	2.8 (2.7-2.9)	0.5 (0.5-0.5)
Tracheal, bronchus, and lung	2163 (2117-2213)	1468 (1424-1514)	695 (674-715)	39.9 (38.7-41.1)	16.3 (15.8-16.7)	1883 (1844-1923)	1287 (1250-1322)	596 (579-614)	35.4 (34.4-36.3)	13.9 (13.5-14.4)
Malignant skin melanoma	309 (238-366)	157 (91-194)	152 (113-207)	4.2 (2.4-5.1)	3.6 (2.7-5.0)	62 (48-70)	33 (20-39)	29 (22-36)	0.9 (0.6-1.1)	0.7 (0.5-0.9)
Nonmelanoma skin cancer	7664 (5251-10 570)	4350 (2974-6035)	3314 (2276-4558)	122.1 (83.9-170.3)	77.9 (53.6-107.0)	65 (63-66)	43 (41-45)	22 (21-22)	1.3 (1.2-1.3)	0.5 (0.5-0.5)
Breast	1961 (1891-2023)	23 (22-24)	1938 (1868-2000)	0.6 (0.6-0.6)	45.9 (44.2-47.4)	612 (589-641)	11 (10-11)	601 (579-630)	0.3 (0.3-0.3)	14.1 (13.6-14.8)
Cervical	601 (554-625)	NA	601 (554-625)	NA	14.5 (13.4-15.1)	260 (241-269)	NA	260 (241-269)	NA	6.1 (5.7-6.4)
Uterine	407 (397-418)	NA	407 (397-418)	NA	9.6 (9.3-9.8)	85 (83-87)	NA	85 (83-87)	NA	2.0 (1.9-2.0)
Ovarian	286 (278-295)	NA	286 (278-295)	NA	6.8 (6.6-7.1)	176 (171-181)	NA	176 (171-181)	NA	4.1 (4.0-4.3)
Prostate	1334 (1171-1698)	1334 (1171-1698)	NA	37.9 (33.0-48.0)	NA	416 (357-490)	416 (357-490)	NA	13.1 (11.2-15.3)	NA
Testicular	71 (69-74)	71 (69-74)	NA	1.8 (1.7-1.9)	NA	8 (7-8)	8 (7-8)	NA	0.2 (0.2-0.2)	NA
Kidney	393 (371-405)	241 (226-249)	152 (141-158)	6.4 (6.0-6.6)	3.7 (3.4-3.8)	139 (129-143)	90 (85-93)	49 (43-51)	2.5 (2.4-2.6)	1.2 (1.0-1.2)
Bladder	474 (462-492)	362 (350-380)	111 (108-115)	10.3 (10.0-10.8)	2.6 (2.5-2.7)	197 (192-206)	145 (140-154)	52 (50-53)	4.4 (4.2-4.7)	1.2 (1.2-1.2)
Brain and nervous system	405 (351-443)	221 (189-251)	184 (132-213)	5.8 (4.9-6.5)	4.6 (3.3-5.3)	247 (213-265)	140 (118-158)	107 (76-119)	3.7 (3.1-4.1)	2.6 (1.9-2.9)
Thyroid	255 (246-272)	76 (73-79)	179 (170-196)	1.9 (1.9-2.0)	4.3 (4.1-4.7)	41 (40-44)	17 (16-18)	24 (23-27)	0.5 (0.5-0.5)	0.6 (0.5-0.6)
Mesothelioma	35 (34-36)	25 (24-26)	10 (10-11)	0.7 (0.7-0.7)	0.2 (0.2-0.3)	30 (29-31)	22 (21-22)	8 (8-9)	0.6 (0.6-0.6)	0.2 (0.2-0.2)
Hodgkin lymphoma	101 (88-119)	61 (50-75)	40 (34-48)	1.6 (1.3-1.9)	1.0 (0.9-1.2)	33 (28-38)	21 (17-26)	12 (10-14)	0.5 (0.4-0.7)	0.3 (0.2-0.3)
Non-Hodgkin lymphoma	488 (479-497)	279 (271-286)	209 (203-214)	7.5 (7.3-7.7)	5.0 (4.9-5.1)	249 (243-253)	144 (140-148)	104 (102-107)	4.0 (3.9-4.1)	2.5 (2.4-2.6)
Multiple myeloma	153 (141-173)	82 (70-98)	70 (67-82)	2.3 (1.9-2.7)	1.6 (1.6-1.9)	107 (99-119)	55 (46-64)	52 (49-58)	1.6 (1.3-1.8)	1.2 (1.1-1.4)
Other	716 (656-740)	383 (340-401)	333 (303-353)	10.3 (9.1-10.8)	8.2 (7.5-8.7)	360 (331-371)	187 (167-194)	173 (156-182)	5.1 (4.6-5.3)	4.2 (3.8-4.4)
Leukemia										

(continued)

Table. 2017 Global Incidence and Deaths for All Cancers and 29 Cancer Groups[a] (continued)

Cancer Type[b]	Incident Cases, Thousands[c]			ASIR (per 100 000)		Deaths, Thousands			ASDR (per 100 000)	
	Total	Male	Female	Male	Female	Total	Male	Female	Male	Female
Acute lymphoid	108 (91-117)	64 (54-71)	43 (34-49)	1.7 (1.5-1.9)	1.2 (0.9-1.4)	52 (46-57)	31 (27-34)	22 (18-24)	0.8 (0.7-0.9)	0.6 (0.5-0.6)
Chronic lymphoid	114 (108-121)	66 (62-72)	48 (44-52)	1.8 (1.7-2.0)	1.1 (1.0-1.2)	35 (34-37)	21 (20-22)	14 (13-15)	0.6 (0.6-0.7)	0.3 (0.3-0.4)
Acute myeloid	140 (127-147)	79 (69-84)	61 (54-67)	2.1 (1.9-2.3)	1.5 (1.3-1.7)	100 (91-105)	57 (51-61)	42 (38-46)	1.6 (1.4-1.7)	1.0 (0.9-1.1)
Chronic myeloid	40 (37-43)	23 (20-24)	17 (15-20)	0.6 (0.6-0.7)	0.4 (0.4-0.5)	24 (22-26)	13 (12-14)	11 (10-13)	0.4 (0.3-0.4)	0.3 (0.2-0.3)
Other	246 (212-267)	142 (121-157)	104 (85-113)	3.9 (3.3-4.3)	2.6 (2.1-2.9)	136 (121-147)	76 (65-84)	61 (51-65)	2.1 (1.8-2.3)	1.5 (1.2-1.6)

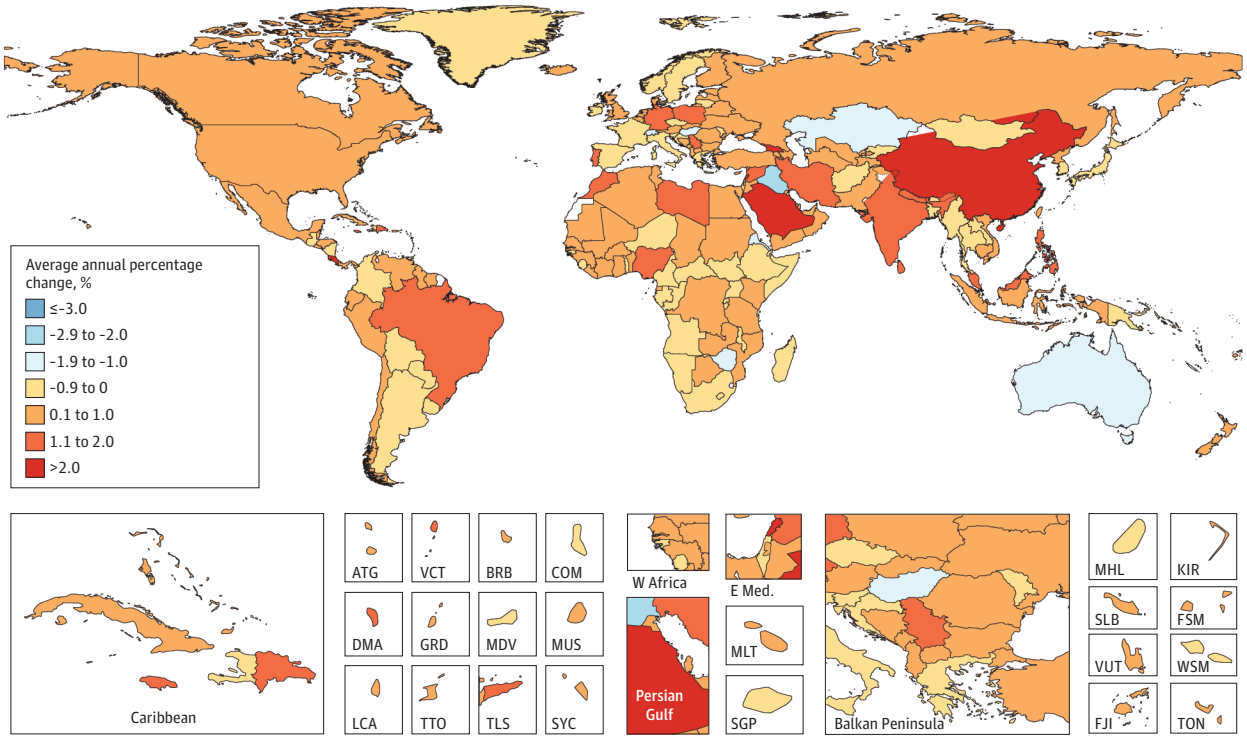
Abbreviations: ASDR, age-standardized death rate; ASIR, age-standardized incidence rate; NA, not applicable.

[a] All data reported as number or rate (95% uncertainty interval).

[b] Cancer groups are defined based on *International Classification of Diseases, Ninth Revision (ICD-9)* and *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10)* codes and include all codes pertaining to malignant neoplasms (*ICD-9* 140-208 and *ICD-10* C00-C96) except for Kaposi sarcoma (C46). eTables 4 and 5 in the Supplement detail how the original *ICD* codes were mapped to the standardized Global Burden of Disease cause list.

[c] Detailed results for incidence, mortality, and disability-adjusted life-years for the global level, by Socio-demographic Index quintile, region, and country can be accessed in eTables 14 and 18 in the Supplement, as well as at https://vizhub.healthdata.org/gbd-compare/.

Figure 1. Average Annual Percentage Change in Age-Standardized Incidence Rate in Both Sexes for All Cancers From 2007 to 2017



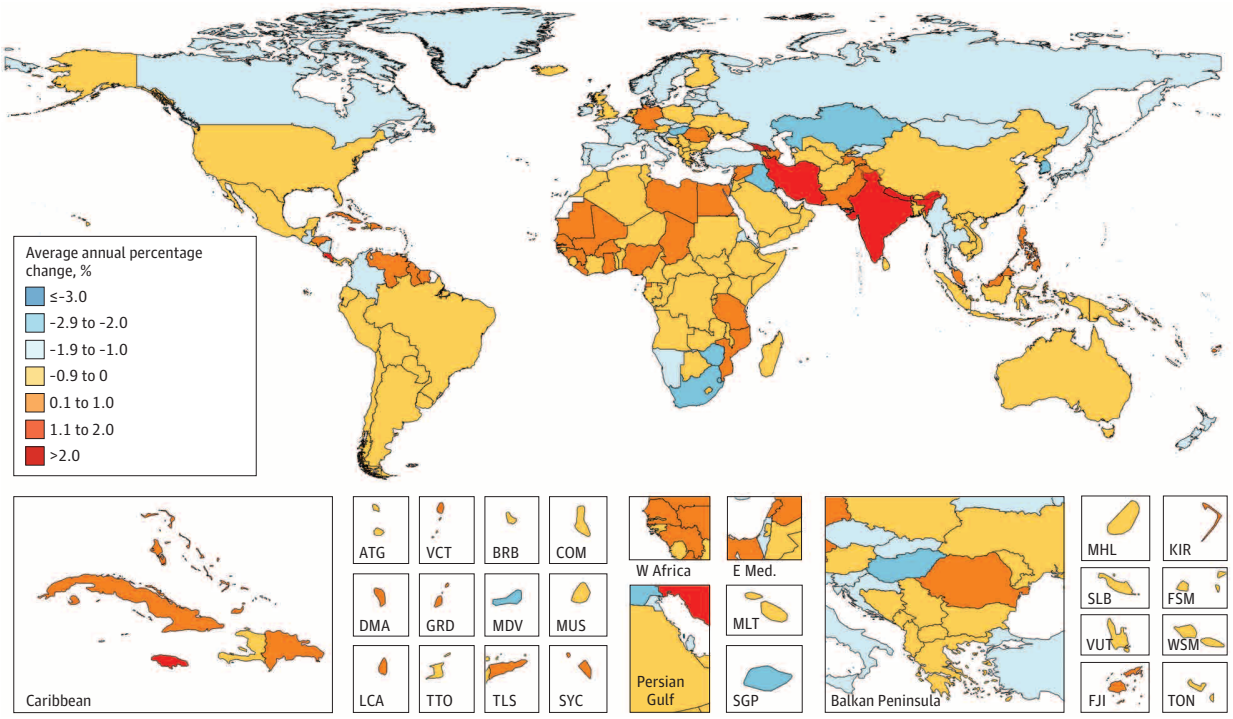
ATG indicates Antigua and Barbuda; BRB, Barbados; COM, Comoros; DMA, Dominica; E Med., Eastern Mediterranean; FJI, Fiji; FSM, Federated States of Micronesia; GRD, Grenada; KIR, Kiribati; LCA, Saint Lucia; MDV, Maldives; MLT, Malta; MUS, Mauritius; MHL, Marshall Islands; SGP, Singapore; SLB, Solomon Islands; SYC, Seychelles; TLS, Timor-Leste; TON, Tonga; TTO, Trinidad and Tobago; VCT, Saint Vincent and the Grenadines; VUT, Vanuatu; W Africa, West Africa; WSM, Samoa.

cident cases in 2017. The majority occurred in women (1.9 million [95% UI, 1.9 -2.0 million]) (Table). Breast cancer was among the top 3 leading causes of cancer in all SDI quintiles except for the high and high-middle SDI quintiles, where it was the fourth most common cancer (eFigure 5 in the Supplement). It caused 601 000 (95% UI, 579 000-630 000) deaths in women and 11 000 (95% UI, 10 000-11 000) deaths in men, making it the fifth leading cause of cancer deaths for both sexes combined in 2017 globally (eFigure 6 in the Supplement). For women, breast cancer was the leading cause of cancer death in 2017 (Table). Breast cancer caused 17.7 million (95% UI, 16.9-18.7 million) DALYs for both sexes, of which 93% came from YLLs and 7% from YLDs (eTable 15 and eFigure 4 in the Supplement). Globally, 1 in 18 women developed breast cancer over a lifetime (eTable 16 in the Supplement). For women, the odds of developing breast cancer were the highest in high SDI countries (1 in 11), and the lowest in low SDI countries (1 in 38). For women, breast cancer was the most common cancer in 143 countries and the most common cause of cancer deaths in 112 countries (eFigures 8 and 10 in the Supplement). Overall, incident cases increased by 35% (95% UI, 30%-39%) because of a change in the population age structure (contributing 15%), population growth (contributing 13%), and an increase in age-specific incidence rates (contributing 7%) (eFigure 11 in the Supplement). Between 2007 and 2017, ASIRs for women decreased in high SDI countries but increased in the other SDI quintiles (eFigures 12-16 in the Supplement).

4. Colon and Rectum Cancer

In 2017, there were 1.8 million (95% UI, 1.8-1.9 million) incident cases of colon and rectum cancer, and 896 000 (95% UI, 876 000-916 000) deaths (Table). Colon and rectum cancer caused 19.0 million (95% UI, 18.5-19.5 million) DALYs in 2017, of which 95% came from YLLs and 5% from YLDs (eTable 15 and eFigure 4 in the Supplement). The odds of developing colon and rectum cancer globally were higher for men than for women (1 in 26 for men vs 1 in 40 for women) (eTable 16 in the Supplement). The highest odds were in the high SDI quintile (1 in 15 for men and 1 in 25 for women) and the lowest in the low SDI quintile (1 in 81 for men and 1 in 98 for women). Between 2007 and 2017, incidence increased by 38% (95% UI, 34%-41%), from 1.3 million (95% UI, 1.3-1.3 million) to 1.8 million (95% UI, 1.8-1.9 million) cases (eTable 14 in the Supplement). Most of this increase can be explained by an aging and growing population (20% and 13%, respectively); however, even with the same population size and age structure, colorectal cancer cases would have increased by 5% between 2007 and 2017 owing to changing age-specific incidence rates. The ASIRs between 1990 and 2017 are similar for men and women

Figure 2. Average Annual Percentage Change in Age-Standardized Mortality Rate in Both Sexes for All Cancers From 2007 to 2017



ATG indicates Antigua and Barbuda; BRB, Barbados; COM, Comoros; DMA, Dominica; E Med., Eastern Mediterranean; FJI, Fiji; FSM, Federated States of Micronesia; GRD, Grenada; KIR, Kiribati; LCA, Saint Lucia; MDV, Maldives; MLT, Malta; MUS, Mauritius; MHL, Marshall Islands; SGP, Singapore; SLB, Solomon Islands; SYC, Seychelles; TLS, Timor-Leste; TON, Tonga; TTO, Trinidad and Tobago; VCT, Saint Vincent and the Grenadines; VUT, Vanuatu; W Africa, West Africa; WSM, Samoa.

at the global level and for all SDI quintiles (eFigures 12-16 in the Supplement).

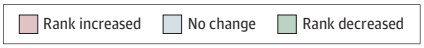
5. Prostate Cancer

In 2017, there were 1.3 million (95% UI, 1.2-1.7 million) incident cases of prostate cancer and 416 000 (95% UI, 357 000-490 000) deaths. Prostate cancer caused 7.1 million (95% UI, 6.1 million-8.4 million) DALYs globally in 2017, with 88% coming from YLLs and 12% from YLDs (eTable 15 and eFigure 4 in the Supplement). Globally, the odds of developing prostate cancer were 1 in 18, ranging from 1 in 52 for low SDI countries to 1 in 9 in high SDI countries (eTable 16 in the Supplement). In 2017, prostate cancer was the cancer with the highest incidence for men in 114 countries and the leading cause of cancer-related deaths for men in 56 countries (eFigures 7 and 9 in the Supplement). The increasing incidence rates, together with an aging and growing population, have led to a 42% (95% UI, 37%-52%) increase in prostate cancer cases since 2007 (940 000 [95% UI, 774 000-1.2 million] in 2007 and 1.3 million [95% UI, 1.2-1.7 million] in 2017). Twenty-one percent of this increase can be attributed to a change in the population age structure, 13% to a change in the population size, and 8% to a change in the age-specific incidence rates (eTable 14 and eFigure 11 in the Supplement).

6. Stomach Cancer

In 2017, there were 1.2 million (95% UI, 1.2-1.3 million) incident cases of stomach cancer and 865 000 (95% UI, 848 000-885 000) deaths worldwide. Stomach cancer caused 19.1 million (95% UI, 18.7-19.6 million) DALYs in 2017, with 98% coming from YLLs and 2% coming from YLDs (eTable 15 and eFigure 4 in the Supplement). One in 33 men and 1 in 78 women developed stomach cancer over a lifetime. The highest odds for men and women were in high-middle SDI countries (1 in 21 and 1 in 57, respectively), and the lowest odds were for men in low SDI countries (1 in 78) and for women in low-middle SDI countries (1 in 104) (eTable 16 in the Supplement). Between 2007 and 2017, stomach cancer moved from the second leading cause of crude cancer YLLs to the third place with a 5% (95% UI, 2%-7%) increase in absolute YLLs (Figure 3). Overall, incidence between 2007 and 2017 increased by 25% (95% UI, 22%-29%), of which a change in the population age structure contributed 19%, population growth 13%, and falling age-specific rates −6% (eTable 14 and eFigure 11 in the Supplement). The ASIRs have dropped substantially since 1990 globally and for all SDI quintiles (eFigures 12-16 in the Supplement).

Figure 3. Cancers Ranked by Absolute Years of Life Lost (YLLs) Among Both Sexes Between 2007 and 2017[a]



Rank	Cancer 2007	Cancer 2017	Rank	Change in Absolute YLLs, % (UI)	Change in Age-Standardized YLL Rate, % (UI)
1	Tracheal, bronchus, and lung cancer	Tracheal, bronchus, and lung cancer	1	24.8 (21.7 to 27.6)	-4.1 (-6.5 to -2.0)
2	Stomach cancer	Liver cancer	2	21.2 (17.0 to 27.4)	-4.6 (-8.0 to 0.1)
3	Liver cancer	Stomach cancer	3	4.8 (2.4 to 7.4)	-18.6 (-20.5 to -16.6)
4	Colon and rectum cancer	Colon and rectum cancer	4	23.8 (19.2 to 27.6)	-4.5 (-8.0 to -1.7)
5	Breast cancer	Breast cancer	5	23.9 (17.3 to 28.7)	-1.7 (-6.8 to 2.1)
6	Esophageal cancer	Esophageal cancer	6	8.9 (5.8 to 12.2)	-16.2 (-18.6 to -13.7)
7	Brain and nervous system cancer	Pancreatic cancer	7	35.8 (32.5 to 38.6)	4.0 (1.5 to 6.1)
8	Cervical cancer	Brain and nervous system cancer	8	18.4 (11.9 to 24.6)	0 (-5.6 to 5.3)
9	Pancreatic cancer	Cervical cancer	9	15.1 (9.4 to 19.1)	-7.2 (-11.8 to -3.9)
10	Non-Hodgkin lymphoma	Non-Hodgkin lymphoma	10	22.1 (15.6 to 26.9)	0.2 (-5.2 to 4.3)
11	Other leukemia	Prostate cancer	11	28.3 (24.9 to 34.5)	-3.6 (-6.2 to 1.2)
12	Prostate cancer	Lip and oral cavity cancer	12	30.5 (23.8 to 36.4)	3.0 (-2.3 to 7.6)
13	Lip and oral cavity cancer	Other leukemia	13	-8.1 (-14.6 to -1.8)	-20.8 (-26.5 to -15.4)
14	Ovarian cancer	Ovarian cancer	14	29.1 (24.8 to 33.1)	1.1 (-2.2 to 4.2)
15	Gallbladder and biliary tract cancer	Gallbladder and biliary tract cancer	15	21.8 (17.8 to 26.3)	-6.8 (-9.9 to -3.5)
16	Acute myeloid leukemia	Bladder cancer	16	22.6 (19.9 to 25.3)	-6.9 (-8.9 to -4.8)
17	Bladder cancer	Other pharynx cancer	17	36.0 (25.4 to 44.2)	6.5 (-1.7 to 12.8)
18	Larynx cancer	Acute myeloid leukemia	18	16.2 (4.4 to 24.6)	-1.4 (-11.3 to 5.8)
19	Kidney cancer	Larynx cancer	19	17.3 (13.9 to 20.9)	-9.1 (-11.7 to -6.4)
20	Acute lymphoid leukemia	Kidney cancer	20	23.1 (18.5 to 27.3)	-3.3 (-6.9 to 0)
21	Other pharynx cancer	Acute lymphoid leukemia	21	5.3 (-8.6 to 15.4)	-4.7 (-17.6 to 4.7)
22	Nasopharynx cancer	Multiple myeloma	22	30.4 (25.6 to 34.4)	0.3 (-3.3 to 3.4)
23	Multiple myeloma	Nasopharynx cancer	23	18.3 (13.9 to 23.1)	-5.0 (-8.5 to -1.3)
24	Uterine cancer	Uterine cancer	24	14.8 (11.6 to 19.0)	-11.2 (-13.7 to -8.0)
25	Hodgkin lymphoma	Malignant skin melanoma	25	16.1 (12.7 to 20.0)	-7.2 (-9.8 to -3.8)
26	Malignant skin melanoma	Hodgkin lymphoma	26	-5.2 (-8.6 to -1.8)	-17.1 (-20.1 to -13.9)
27	Nonmelanoma skin cancer	Nonmelanoma skin cancer	27	30.0 (26.2 to 32.7)	0.5 (-2.3 to 2.6)
28	Thyroid cancer	Thyroid cancer	28	22.1 (16.7 to 28.0)	-2.3 (-6.6 to 2.4)
29	Chronic myeloid leukemia	Mesothelioma	29	21.0 (13.8 to 27.3)	-5.4 (-10.8 to -0.8)
30	Mesothelioma	Chronic myeloid leukemia	30	-1.7 (-5.2 to 1.5)	-19.7 (-22.4 to -17.1)
31	Chronic lymphoid leukemia	Chronic lymphoid leukemia	31	18.3 (14.2 to 22.4)	-9.2 (-12.3 to -6.1)
32	Testicular cancer	Testicular cancer	32	0.9 (-3.3 to 6.3)	-10.8 (-14.5 to -6.1)

UI indicates uncertainty interval.

[a] Excluding other cancer.

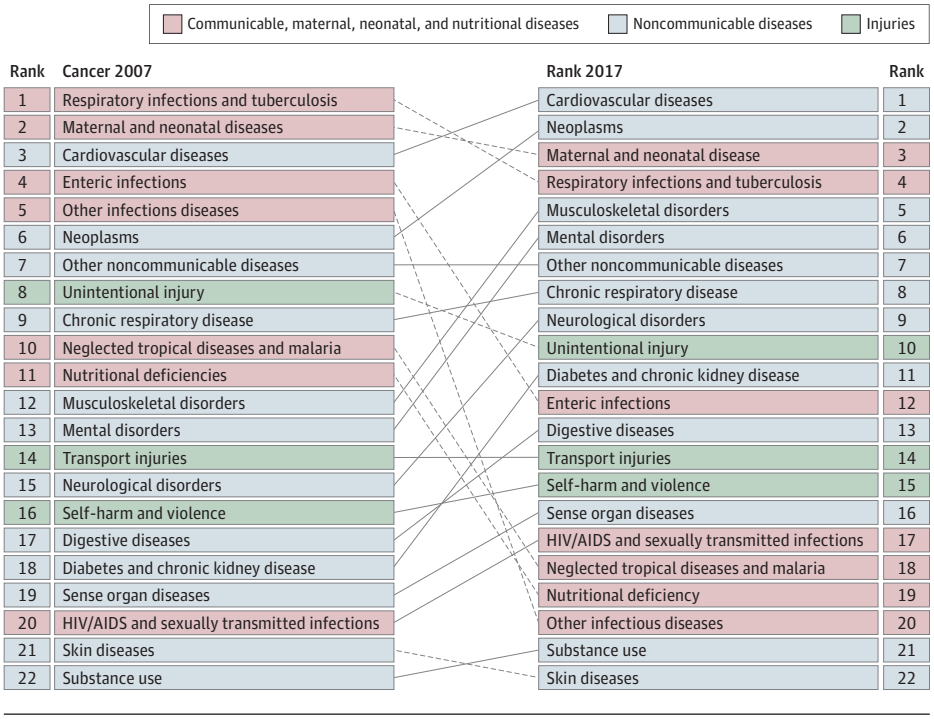
7. Liver Cancer

In 2017, there were 953 000 (95% UI, 917 000-997 000) incident cases of liver cancer globally and 819 000 (95% UI, 790 000-856 000) deaths. Liver cancer caused 20.8 million (95% UI, 19.9-21.8 million) DALYs in 2017, with 99% coming from YLLs and 1% coming from YLDs (eTable 15 and eFigure 4 in the Supplement). Globally, liver cancer was more common in men, with 1 in 42 men developing liver cancer compared with 1 in 118 women. The highest odds of developing liver cancer were in high-middle SDI countries for men (1 in 31) and in middle SDI countries for women (1 in 94), whereas the lowest were seen in low SDI countries (1 in 98 men and 1 in 177 women) (eTable 16 in the Supplement). Population aging and population growth were the drivers of the increase from 705 000 (95% UI, 690 000-734 000) cases in 2007 to 953 000 (95% UI, 917 000-997 000) cases in 2017 (eTable 14 and eFigure 11 in the Supplement). Of the 35% increase in cases between 2007 and 2017, 17% was due to population aging, 13% due to population growth, and 6% due to an increase in age-specific incidence rates.

8. Cervical Cancer

In 2017, 601 000 (95% UI, 554 000-625 000) women developed cervical cancer worldwide, and it caused 260 000 (95% UI, 241 000-269 000) deaths (Table). Cervical cancer caused 8.1 million (95% UI, 7.5-8.4 million) DALYs, with 96% coming from YLLs and 4% from YLDs (eTable 15 and eFigure 4 in the Supplement). Globally, 1 in 65 women developed cervical cancer during a lifetime (eTable 16 in the Supplement). The odds were the highest in low SDI countries (1 in 40) and the lowest in high SDI countries (1 in 106). In 2017, cervical cancer was the most common incident cancer for women in 50 countries (eFigure 8 in the Supplement) and the most common cause of cancer deaths in 39 countries (eFigure 10 in the Supplement). Between 2007 and 2017, incident cases increased by 19% (95% UI, 13%-23%) globally. Population growth contributed 13% and population aging 9%, while falling age-specific incidence rates offset this increase by −3% (eFigure 11 and eTable 14 in the Supplement). Deaths increased by 19% (95% UI, 13%-23%) between 2007 and 2017, and DALYs by 15% (95% UI, 10%-19%).

Figure 4. Change in the Absolute Number of Disability-Adjusted Life-Years (DALYs) Between 1990 and 2017 for Both Sexes at the Global Level for Global Burden of Disease Level 2 Causes[a]



The cause neoplasms includes all cancers as defined under *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10)* causes C00 through C96, as well as myelodysplastic, myeloproliferative, and other hematopoietic neoplasms (*ICD-10* codes D45-D47.9).

[a] All diseases are grouped into 22 mutually exclusive and collectively exhaustive causes.

The ASIRs decreased globally and for all SDI quintiles (eFigures 12-16 in the Supplement).

9. Non-Hodgkin Lymphoma

In 2017, there were 488 000 (95% UI, 479 000-497 000) incident cases of non-Hodgkin lymphoma and 249 000 (95% UI, 243 000-253 000) deaths. Non-Hodgkin lymphoma caused 7.0 million (95% UI, 6.8-7.2 million) DALYs in 2017, with 97% coming from YLLs and 3% from YLDs (eTable 15 and eFigure 4 in the Supplement). Globally, 1 in 108 men and 1 in 162 women developed non-Hodgkin lymphoma over a lifetime. The highest odds were in high SDI countries (1 in 54 for men and 1 in 80 for women) and the lowest in low SDI countries (1 in 221 for men and 1 in 322 for women) (eTable 16 in the Supplement). Globally, incident cases between 2007 and 2017 increased by 39% (95% UI, 35%-42%), of which 15% was due to changing population age structure, 13% due to population growth, and 11% due to change in incidence rates (eTable 14 and eFigure 11 in the Supplement).

10. Bladder Cancer

In 2017, there were 474 000 (95% UI, 462 000-492 000) incident cases of bladder cancer and 197 000 (95% UI, 192 000-206 000) deaths. Bladder cancer caused 3.6 million (95% UI, 3.5-3.8 million) DALYs in 2017, with 93% coming from YLLs and 7% from YLDs (eTable 15 and eFigure 4 in the Supplement). Globally, 1 in 74 men and 1 in 301 women developed bladder cancer over a lifetime. The highest odds were in high SDI countries (1 in 42 for men and 1 in 185 for women) and the lowest in low SDI countries (1 in 198 for men and 1 in 489 for women) (eTable 16 in the Supplement). Globally, incident cases between 2007 and 2017 increased by 32% (95% UI, 30%-35%), of which 20% was due to changing population age structure and 13% to population growth (eTable 14 and eFigure 11 in the Supplement).

Cancer in Comparison to Other Diseases

Within the 22 mutually exclusive and collectively exhaustive GBD level 2 disease categories (eTable 17 in the Supplement), neoplasms ranked last for incidence in 1990 and 2017 (eTable 18 in the Supplement). For prevalence, neoplasms ranked last in 1990 but surpassed enteric infections in 2017. The YLDs ranking for neoplasms also increased between 1990 and 2017 from the 21st to the 19th position. Mortality due to neoplasms remained at the second place between 1990 and 2017. The largest increase was seen for neoplasm YLLs and DALYs, which increased from the sixth place in 1990 to the second place in 2017 after cardiovascular diseases (**Figure 4**). The 4 causes with higher DALYs in 1990 that had been surpassed by neoplasms in 2017 are respiratory infections and tuberculosis, maternal and neonatal disorders, enteric infections, and other infections.

Discussion

The GBD study results are updated on an annual basis. In this article we focus on changes over the past decade and present the most recent results from the GBD 2017 study using cancer registry, vital registration, and verbal autopsy data to esti-

mate the burden of cancer for 195 countries and territories from 1990 through 2017.[13,14] All results presented can also be found online at https://vizhub.healthdata.org/gbd-compare/ and http://ghdx.healthdata.org/gbd-results-tool. For this article, we also compare cancer burden with other diseases.

The GBD 2017 results show that there are 24.5 million incident cancer cases worldwide (16.8 million without NMSC) and 9.6 million deaths, which is similar to the latest GLOBOCAN estimates for 2018 that estimate 17.0 million cases (without NMSC) and 9.4 million deaths.[15]

The largest change in our estimates compared with the last iteration of the GBD study (GBD 2016) are the incidence estimates for NMSC, which have substantially increased. Despite being the most common incident cancer in many populations, cancer registry data to inform incidence estimates are often unreliable or nonexistent. For GBD 2017 we have therefore used Marketscan data for the United States, which has led to substantially higher estimates for NMSC.[16]

A key strength of the GBD study is the comparative health assessment. Our analysis shows how cancer has increased in importance as a global health problem. Although it ranked sixth in 1990 among the top causes for DALYs worldwide, it has risen to the second place in 2017 behind cardiovascular diseases. Cancer now occupies the second place in the ranking of global deaths, YLLs, and DALYs, and is among the top 2 leading causes of deaths, YLLs, and DALYs in the highest 3 SDI quintiles. This shift in disease burden owing to the demographic and epidemiological transitions has important implications on health policy: ensuring access to universal health coverage and protection against catastrophic health expenditure directly related to the cancer treatment, but also against the long-term costs associated with a cancer diagnosis for a household, has to be prioritized.[17] Fifty percent of cancer cases occur in high SDI countries, but only 30% of cancer deaths, 25% of cancer DALYs, and 23% of cancer YLLs. To ensure sustainable global development, increased efforts are needed to reduce these health inequalities. Recognizing the strong interdependencies between socioeconomic status and health and the large contribution of cancer to the overall disease burden is a first step in making investments in cancer prevention and treatment a priority.[18] Cervical cancer is likely the best example of inequalities in cancer with vast differences in burden by SDI. As a completely preventable cancer where cost-effective vaccination[3] and screening approaches are available, cervical cancer has recently gained global attention through the World Health Organization's call for elimination.[19] Falling incidence rates in all SDI quintiles are encouraging, but countries with the least resources are still facing the largest burden because of lack of screening programs. Immunization against human papillomavirus, screening, and treatment of cervical cancer is therefore of utmost importance in all socioeconomic settings.

Deaths due to cancer contribute the majority of total health loss measured in DALYs, with disability contributing less than 12% for all cancers. As access to cancer care increases and treatments improve, cancer mortality decreases, but prevalence and disability in the survivor population increase, which is already the case in some high-income countries.[20] The World Health Organization Global Action Plan for the Prevention and Control of NCDs and the United Nations Sustainable Development Goals focus on the reduction of premature mortality as the first goal. At the same time, infrastructure should be planned that can address the growing survivor population's need.

Limitations

The most important limitation for the GBD, as for other disease burden estimation, is the lack of data for many locations. A key GBD principle is to take advantage of all relevant data sources. This means for cancer estimation that incidence data from cancer registries, as well as mortality data from vital registration systems or verbal autopsies, is used to produce disease burden estimates. Despite these broad inclusion criteria for different types of data sources, certain locations have neither of these data sources available, and estimates rely either on predictive covariates or trends from neighboring locations. Also, diagnostic accuracy for cause of death data and ascertainment bias in cancer registries remains a limitation, which requires corrections for underregistration and redistribution algorithms for insufficiently specific or implausible diagnostic codes. Because of a lag in data availability, estimates for the most recent years are based on past time trends and covariates rather than data, which is reflected in larger uncertainty. Scarcity of reliable survival data worldwide requires the estimation of survival based on the mortality-to-incidence ratio, which is a surrogate for survival. Because in the majority of deaths due to Kaposi sarcoma the underlying cause of deaths is AIDS, deaths and incidence of Kaposi sarcoma are not estimated in the GBD. Also, common pediatric cancers are not estimated separately in the GBD and are estimated under the aggregated cause "other malignant neoplasms."

Conclusions

The national epidemiological profiles of cancer burden in the GBD study show large heterogeneities, which are a reflection of different exposures to risk factors, economic settings, lifestyles, and access to care. The GBD study can be used by policy makers and other stakeholders to develop and improve local cancer control in order to achieve the global targets and improve equity in cancer care.

ARTICLE INFORMATION

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